

ELECTRONIC SIGNAL TRANSMISSION AND SWITCHING JACK

Field of the Invention

The present invention relates to electronic signal transmission and switching. More specifically, the present invention relates to multi-function, multi-circuit switching jack modules for the audio, broadcast and entertainment industries.

Background of the Invention

Analog and digital audio signals are transmitted over balanced and shielded twisted pair cables. These cables include a pair of insulated conductors, either stranded or solid wire, which are surrounded by a metal foil shield. The shield serves to reduce the impact of external electromagnetic inference on the signal being transmitted over the cable and also to reduce the electromagnetic field generated by the signals being transmitted over the cable.

In a professional audio and video industry application, a large number of such cables will be in use to carry signals from sources to processing devices such as mixers or equalizers and further to amplifiers or other downstream devices. The environment in which these signals are generated is quite dynamic and requires the ability to quickly and easily shift connections between sources, and downstream devices. A jack field provides this sort of connection flexibility. A jack field allows incoming signals to be patched into circuits connected to devices and signals returning from devices to be patched into circuits connected to downstream devices. Each jack in this jack field requires three conducting paths, two for the balanced audio signal and one for the shield to serve as a grounding path. There are three principal ways to connect these jacks to one another, depending on the needs of the particular situation.

First, a jack field may be set up for non-normal connections, meaning that each jack is connected directly to another jack. When a connection between devices is needed, a patch cord must be used. For example, a source is connected to J1 and J1 is electronically linked to jack 1. A device is connected to J1 and J2 is

electronically linked to jack 2. To link the source to the device, a patch cord would be used to electronically link jack 1 to jack 2, as shown in FIG. 28b. Without a patch cord in place in jack 1 or jack 2, no connection will exist for either the source or the device, as shown in FIG. 28a.

5 A second method of connecting jacks is referred to as normal. As an example, a source and an device are designated to be linked together electronically as a default or normal condition, but it is still necessary to be able to switch the source to another device, or connect another source to the device, on occasion. To accomplish this, a source is connected to J1 and an device is connected to J2. J1 is also
10 electronically connected to J2. Jacks 1 and 2 are placed in the circuit connecting J1 and J2, as shown in FIG. 29a, and are configured such that, if a patch cord is inserted into jack 1 or jack 2, the connection between J1 and J2 is broken, as shown in FIG. 29b. If a patch cord is inserted into jack 1, it will not only break the J1-J2 connection, but the patch cord will be electronically linked to the source connected to J1. Similarly, a patch
15 cord inserted into jack 2 will break the J1-J2 connection and be electronically linked with the device connected to J2. So, in a normal configured jack field, two elements can be configured to be normally electronically connected to one another but that normal connection can be broken and the connections redirected as necessary.

20 A third method of connecting jacks is referred to as half-normal. In the default state, a source connected to J1 and an device connected to J2 are connected together through jack 1 and jack 2, as shown in FIG. 30a. This arrangement allows, for example, the feed coming from a source to J1 to be monitored by a device connected into the normal circuit by a patch cord inserted into jack 1 without the insertion of the patch cord into jack 2 causing the connection between the source and the device
25 connected to J2 to be broken, as shown in FIG. 30b. In addition, the connection between the source and the device can be broken by the insertion of a patch cord in jack 2. When a patch cord is inserted into jack 2, the patch cord in jack 1 can then be used to patch the source to another device and patch cord in jack 2 can be used to patch another source to the device, as shown in FIG. 30c.

Another aspect of the connection between jacks and devices connected to the jacks is the treatment of the shield. Typically, the shield of the cable connected to the first jack is electronically linked to the shield of the cable connected to the second jack when the first jack and the second jack are electronically linked. It is desirable to have the ability to link the shields either individually or jointly to a common ground. This allows maximum flexibility in the configuration in the electronic linkages between the jacks, depending on the devices connected to the jacks.

While these connection schemes within a jack field are known, the ability of users to reconfigure a jack field or a jack pair within a jack field from one to another of the three arrangements could be improved. A variety of approaches have been used in the past, including wire wrapping leads together between the jacks, soldering the leads together between the jacks, using straps or jumpers to reconfigure connections between jacks, or using small metal plates of different sizes and shapes to reconfigure the connection between jacks. In some designs, the entire jack field would need to be exchanged to reconfigure the arrangement. This type of design does not allow the users to configure the circuits connected to individual devices and required all devices connected to a particular jack field to be configured identically. Improvement to the ability to create and modify the state of the connection between jacks and individual devices in the jack fields is desirable.

In addition, users of these types of devices and jack fields have very complex and dense wiring environments within their physical plants. Improvement to the density of connections possible in the limited space available within their physical plant without a loss of flexibility of configuration is desirable.

Summary of the Invention

The present invention relates to switching circuits such as for an audio signal transmission environment. One aspect of the invention is a switching module which contains pairs of audio jacks for receiving audio plugs and circuitry connecting these jacks to a second set of connectors. Included in the circuitry are two position

switches which allow the switching module to be configured for several different switching conditions.

A further aspect of the invention is a method of configuring the switches to provide straight through, normal and half normal connections between the audio jacks and the second set of connectors.

5 A further aspect of the invention is a system including a chassis, with switching modules and connecting modules, the connecting modules electronically linking audio cables connected to the connecting modules to cables connected to audio plugs inserted into audio jacks of the switching modules.

10 A variety of advantages of the invention will be set forth in part and the description that follows, and in part will be apparent from the description, or may be learned by practicing the invention. It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory only and are not restrictive of the invention as claimed.

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Brief Description of the Drawings

The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate several aspects of the invention and together with the description, serve to explain the principles of the invention. A brief description of the drawings is as follows:

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FIG. 1 is a perspective view of the first side of an audio signal transmission chassis with four switching modules mounted in the chassis and a fifth module in position for insertion into the chassis.

FIG. 2 is a perspective view of the second side of the chassis of FIG. 1, showing three connecting modules mounted in the chassis.

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FIG. 3 is a first perspective view of one of the switching modules of FIG.

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FIG. 4 is second perspective view of the switching module of FIG. 3.

FIG. 5 is a side view of the switching module of FIG. 4

- FIG. 6 is an end view of the switching module of FIG. 4.
- FIG. 7 is an exploded view of the switching module of FIG. 4.
- FIG. 8 is a circuit diagram of the switching module of FIG. 4.
- FIG. 9 is a switching legend for the switching module of FIG. 4.
- 5 FIG. 10 is a first perspective view of one of the connecting modules of
- FIG. 2.
- FIG. 11 is a second perspective view of the connecting module of FIG.
- 10 10.
- FIG. 12 is a view of the cable connection side of the connecting module
- 10 of FIG. 10.
- FIG. 13 is a view of the switching module connecting side of the
- connecting module of FIG. 10.
- FIG. 14 is an end view of the switching module of FIG. 10.
- FIG. 15 is a top view of the switching module of FIG. 10.
- 15 FIG. 16 is a first perspective view of a second connecting module of
- FIG. 2.
- FIG. 17 is a second perspective view of the connecting module of FIG.
- 16.
- FIG. 18 is a view of the cable connection side of the connecting module
- 20 of FIG. 16.
- FIG. 19 is a view of the switching module connecting side of the
- connecting module of FIG. 16.
- FIG. 20 is an end view of the switching module of FIG. 16.
- FIG. 21 is a top view of the switching module of FIG. 16.
- 25 FIG. 22 is a first perspective view of a third connecting module of FIG.
- 2.
- FIG. 23 is a second perspective view of the connecting module of FIG.
- 22.

FIG. 24 is a view of the cable connection side of the connecting module of FIG. 22.

FIG. 25 is a view of the switching module connecting side of the connecting module of FIG. 22.

5 FIG. 26 is an end view of the switching module of FIG. 22.

FIG. 27 is a top view of the switching module of FIG. 22.

FIG. 28a is a diagram of a prior art non normal circuit without a patch cord.

FIG. 28b is a diagram of a prior art non normal circuit with a patch cord.

10 FIG. 29a is a diagram of a prior art full normal circuit without a patch cord.

FIG. 29b is a diagram of a prior art full normal circuit with a patch cord.

FIG. 30a is a diagram of a prior art half normal circuit without a patch cord.

15 FIG. 30b is a diagram of a prior art half normal circuit with a monitor connected with a patch cord.

FIG. 30c is a diagram of a prior art half normal circuit with a patch cord.

FIG. 31 is a front perspective view of an alternative designation lens for holding indicia.

20 FIG. 32 is a rear perspective of the designation lens of FIG. 31.

FIG. 33 is a rear view of the designation lens of FIG. 31.

FIG. 34 is a top view of the designation lens of FIG. 31.

FIG. 35 is a rear view of the designation lens of FIG. 31.

25 FIG. 36 is a cross-sectional view of the designation lens of FIG. 31 taken along AA in FIG. 35.

Detailed Description

Reference will now be made in detail to exemplary aspects of the present invention that are illustrated in the accompanying drawings. Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or like parts.

Referring now to FIG. 1, an audio signal transmission chassis 10 is shown with four switching modules 100 mounted within the chassis and a fifth switching module 100 in position to be inserted into chassis 10. Switching modules 100 are mounted by engaging card slots 12 in upper plate 14 and lower plate 16. Removable fasteners are then inserted through each module 100 and engaged by openings 18 in first upper plate flange 20 and first lower plate flange 22. The fasteners are not shown in FIG. 1 but may include any type of suitable removable fastener such as a screw.

Chassis 10 comprises upper plate 14 and lower plate 16 which are joined to each other by end plates 24 and a series of intermediate plates 26. Mounting flanges 30 are included at the switching module end of sides 24. Mounting flanges 30 may be used to mount chassis 10 in a convenient location, such as in an equipment rack. End plates 24 and intermediate plates 26 cooperate to form switch module bays 28. Each bay 28 is configured to receive eight switching modules 100. Each bay 28 includes eight card slots 12 in both upper plate 14 and lower plate 16 and eight openings 18 in both upper plate flange 20 and lower plate flange 22 to allow the eight switching modules 100 to be mounted to the chassis. Projections 27 project transversely into slots 12 for centering modules 100.

Also mounted within each bay 28 of chassis 10 is a connecting module. Three different connecting modules 200, 300 and 400 are shown in FIG. 1. Different combinations of connecting modules 200, 300 and 400 can be used as desired. Further descriptions of switching module 100 and connecting modules 200, 300 and 400 are included below. A similar chassis to chassis 10 of FIGS. 1 and 2 is shown and described in U.S. Patent No. 6,186,798. Further connecting modules are also shown and described in U.S. Patent No. 6,186,798. Chassis 10 is also useable with the jack

access cards or modules shown and described in U.S. Patent No. 6,186,798. The disclosure of U.S. Patent No. 6,186,798 is incorporated by reference. It is anticipated that module 100 can be adapted for use with a variety of standard and non-standard chassis and also in conjunction with other mounting systems.

5 Referring now to FIG. 2, a second perspective view of chassis 10 is shown. Connecting modules 200, 300 and 400 are mounted to chassis 10 with fasteners inserted through the connecting modules and into openings 18 in second upper plate flange 32 and second lower plate flange 34. The fasteners are not shown in FIG. 2 but may include any type of suitable removable fastener such as a screw.

10 Referring now to FIGS. 3 through 9, further details of switching modules 100 are shown. FIGS. 3 through 6 show an assembled switching module 100. A card edge connector plate 102 is provided for connecting to one of connecting modules 200, 300 or 400. Card edge connector plate 102 includes ten card edge contacts 104 on each side of plate 102, for a total of twenty possible card edge connections. Connectors 118
15 are used to electronically connect contacts 104 with circuitry on circuit board 122. Standoffs 120 are used to physically connect plate 102 to jack housing 124. Each of the ten posts 128 that are part of each connector 118 extends through a hole 127 in plate 102 and is electronically connected to a single contact 104. Each of the ten posts 128 that are part of each connector 118 extends through a hole 129 in circuit board 122 and
20 is electronically connected to a circuit on board 122. These circuits will be described in detail below but are not shown in FIGS. 3 through 9 for clarity. Offsetting of card edge plate 102 allows module 100 to be used in the arrangement described in U.S. Patent No. 6,186,798. While modules 100 can be used in a variety of environments to support audio patching, the utility of these modules is enhanced by ensuring interchangeability
25 with an existing rack system such as described in the '798 patent.

A switch bank 114 with twelve switches 116 is mounted to circuit board 122 with switch contacts 132 extending through holes 133. Each switch 116 has two positions, open and closed. Switches 116 can be either sliding or rocker switches or some other form of two position switch appropriate for mounting on a circuit board.

Switches 116 may sometimes be referred to as DIP switches. Switch contacts 132 are linked into the circuitry on circuit board 122. The circuitry on circuit board 122 also is electronically linked with spring contacts 134 which extend through holes 135 in circuit board 122. The circuitry on circuit board 122 will be described in detail below. Each of these spring contacts 134 is part of a spring 136 which is received in a slot 138 of jack housing 124. The configuration and function of springs 136 will be described below in the description of the circuitry of module 100. Spring cover 130 encloses springs 136 and slots 138.

On an opposite side of switching module 100 from card edge contacts 104 are four audio jacks 106 positioned with access openings along face 140 of jack housing 124 which are sized to receive bantam audio plugs (not shown). It is anticipated that other types of jacks and plugs may be utilized with module 100. A bantam audio plug for use with module 100 has tip, ring and shield contacts which are attached to the tip, ring and shield conductors of a shielded audio cable. When a bantam audio plug is inserted into a jack 106, the tip, ring and shield contacts of the plug come into contact with selected springs 136 and thus to the circuitry of switching module 100. At either end of face 140 are mounting extensions 112 through which are holes 111 for receiving fasteners 110. Fasteners 110 cooperate with openings 18 of chassis 10 for mounting switching modules 100 to chassis 10. On face 140 adjacent to each jack 106 are designation devices 108. In the preferred embodiment, each designation device 108 is at least partially transparent to visible light and holds indicia of the circuit linked to an adjacent jack opening 106. Additional details of designation devices 108 are provided below. Extending from jack housing 124 are tabs 126. Tabs 126 are sized and shaped to engage slots 12 in chassis 10 so that a module 100 can be slid into a bay 28 for mounting with fasteners 110 into openings 18 in first upper plate flange 20 and first lower plate flange 22.

Referring now to FIG. 8, the wiring schematic of the circuitry of module 100 and the configuration of springs 136 is shown. J1, J2, J3 and J4 represent the jack openings 106 through face 140 of module 100. Without a plug inserted into jack

opening 106, a normal connection exists between the springs labeled R and RN and between the springs labeled T and TN. When a bantam audio plug is inserted into one of the jack openings 106, springs labeled T and R are displaced, breaking the connection with springs TN and RN, respectively. When the plug is fully inserted into jack opening 106, the tip, ring and shield contacts of the plug are electronically connected with the springs labeled T, R and S, respectively. Card edge connectors 104 are grouped into four groups, G1, G2, G3 and G4, each group including a tip connector, a ring connector and a shield connector. Through the connection modules 200, 300 and 400 described below, each group of three card edge connectors is connected to a shielded cable leading to an audio source or other audio signal device. As shown in switching module 100, only thirteen card edge connections 104 are used, one for each T, R and S spring in jacks J1, J2, J3 and J4, and one to act as a common ground.

Referring now to FIGS. 8 and 9, the operation of switches 116 to change the configuration of switching module 100 can be seen. Module 100 can be configured in three different conditions: no normal, half normal and full normal. To configure module 100 to a no normal condition, all switches 116 are left open. This condition has no normal state connections between any of G1, G2, G3 or G4. The only way a cable linked to G1 connectors can be linked to a cable linked to G2 connectors is through the use of a patch cord with audio bantam plugs inserted into J1 and J2. To configure module 100 to a full normal condition, switches 116 labeled 1, 3, 7 and 9 are closed, with the remaining switches left open. This full normal condition allows a default electronic connection between G1 and G2, and between G3 and G4, when no plugs are present in J1, J2, J3 and J4. For example, assume G3 is linked to an audio source and this audio source is normally used in conjunction with a particular audio effects device linked to G4. Without an audio plug in either J3 or J4, this normal connection exists. When an alternative connection is required, patch cords can be inserted in J3 and J4 to disconnect the source and the effects device from each other and patch them into other circuits.

To configure module 100 to a half normal condition, switches 116 labeled 2, 4, 8 and 9 are closed and the remaining switches are left open. This condition also provides a default electronic connection between G1 and G2, and G3 and G4. In this half normal condition, an audio plug inserted into J1 or J3 will permit another 5 device or monitor to be linked into the default circuit without breaking the circuit. If it is desirable to break the default circuit and patch the attached devices to alternative circuits, inserting patch cords into J2 and J4 will serve to break the normal circuits and allow patching to be carried out.

As shown in FIG. 8, the shield connectors of G1, G2, G3 and G4 are 10 connected directly to the springs labeled S in J1, J2, J3 and J4, which will in turn contact the shield contact of an audio plug inserted into the jack. In some situations, it is desirable to have the shield connections also tied into a common ground or shield buss. Switches 116 labeled 5, 6, 11 and 12 allow the shield circuit between G1 and J1, G2 and J2, G3 and J3, and G4 and J4, respectively, to be tied into the common ground.

Referring now to FIGS. 10 through 27, connecting modules 200, 300 and 400 will be described. The role of connecting modules 200, 300 and 400 is to 15 electronically link card edge contacts 104 to audio cables. These connecting modules are flexible in terms of the connectors they provide for linking to these audio cables and the nature of the internal connection between the card edge contacts and the rear 20 connectors. Three alternatives each of cable connectors and internal connection are illustrated by modules 200, 300 and 400. All three of the module alternatives include card edge slots for receiving card edge plates 102 and electronically linking with card edge contacts 104. Additional alternative versions of connecting modules are shown in the above-referenced U.S. Patent No. 6,186,798.

Referring now to FIGS. 10 through 15, module 200 includes insulation 25 displacement connectors (IDCs) 214 for linking to individual conductors within audio cables and utilizes wire wrap tails 218 within the module to link the card edge connectors to the IDCs 214. Module 200 includes a C-shaped, open-ended housing 202, which also serves as the mounting surface for card edge slots 220. Card edge slots 220

serve to interface with card edge plates 102 of modules 100 and include contacts which electronically link card edge contacts 104 with wire wrap tails 218. In housing 202 are mounting openings 206 and 210 for mounting module 200 to chassis 10 with fasteners inserted through openings 206 and 210 and into openings 18 in second upper plate flange 32 and second lower plate flange 34. Openings 206 include a larger lower opening 205 and a smaller upper opening 207 for passage of a fastener head and shaft, respectively. Openings 210 are configured as downward facing slots. Even though the ends of module 200 are open, access to the fasteners for mounting or removal from a chassis 10 may be difficult, since multiple modules 200, 300 and 400 may be mounted side-by-side, blocking the open ends. Upper access slots 208 and lower access slots 212 allow users to see and engage the fasteners, such as with a screwdriver, even when additional modules are mounted alongside module 200.

Mounted across the open end of housing 202 is plate 204. Plate 204 serves as the mounting surface for IDCs 214, which are located in eight vertical columns corresponding to the eight card edge slots 220 mounted to housing 202. Each row of IDCs 214 includes twelve individual connectors, for a total of 96 possible connections. Since audio cables include three conductors each, tip, ring and shield, a total of thirty-two cable connections are possible with module 200. Each IDC 214 is linked through plate 204 to a connecting post 216 within housing 202. Links are made between wire wrap tails 218 and connecting posts 216 with individual wires. Since a total of 96 wires linking posts 216 and wire wrap tails 218 are possible within housing 202, these wires have been omitted from the FIGS. for clarity. Wire organizers 222 are provided below IDCs 214 for collecting and organizing the audio cables attached to module 200. Also mounted on plate 204 are two separate grounds 224 and 226. Ground 224 is a common chassis ground and ground 226 provides an isolated ground. Card edge contact 104 designated to be the common ground contact will be linked to one or the other of these two grounds by a wire from the corresponding wire wrap connector 218, depending on wiring requirements of a particular application.

Referring now to FIGS. 16 through 21, module 300 includes 3-pin connectors 314 for linking to individual conductors within audio cables and utilizes flex-circuit 318 within the module to link the card edge connectors to the 3-pin connectors 314. Module 300 includes a C-shaped, open-ended housing 302, which also serves as the mounting surface for card edge slots 320. Card edge slots 320 serve to interface with card edge plates 102 of modules 100 and include contacts which electronically link card edge contacts 104 with posts 322. In housing 302 are mounting openings 306 and 310 for mounting module 300 to chassis 10 with fasteners inserted through openings 306 and 310 and into openings 18 in second upper plate flange 32 and second lower plate flange 34. Openings 306 include a larger lower opening 305 and a smaller upper opening 307 for passage of a fastener head and shaft, respectively. Openings 310 are configured as downward facing slots. Even though the ends of module 300 are open, access to the fasteners for mounting or removal from a chassis 10 may be difficult, since multiple modules 200, 300 and 400 may be mounted side-by-side, blocking the open ends. Upper access slots 308 and lower access slots 312 allow users to see and engage the fasteners, such as with a screwdriver, even when additional modules are mounted alongside module 300.

Mounted across the open end of housing 302 is plate 304. Plate 304 serves as the mounting surface for 3-pin connectors 314, which are located in eight vertical columns corresponding to the eight card edge slots 320 mounted to housing 302. Each row of 3-pin connectors 314 includes 4 connectors, each with 3 connections, for a total of 96 possible connections. Since audio cables include three conductors each, tip, ring and shield, a total of thirty-two cable connections are possible with module 300. Each 3-pin connector 314 is linked through plate 304 to a connecting post 316 within housing 302. Links are made between posts 322 and connecting posts 316 with flex circuit 318, which is a printed circuit board created from flexible materials which enable it to be shaped as shown in the FIGS. Also mounted on plate 304 are two separate grounds 324 and 326. Ground 324 is a common chassis ground and ground 326 provides an isolated ground. Card edge contact 104 designated to be the common

ground contact will be linked to one or the other of these two grounds by a circuit path on flex circuit 318 from corresponding post 322, depending on wiring requirements of a particular application.

Referring now to FIGS. 22 through 27, module 400 is a more compact connection module utilizing board-to-board circuit connectors and 90-pin connectors to link switching modules 100 to audio cables. Module 400 includes housings 402 and 404. Housing 402 holds card edge slots 420 and housing 404 holds 90-pin connectors 414. Card edge slots 420 serve to interface with card edge plates 102 of modules 100 and include contacts which electronically link card edge contacts 104 with board 422. One or more board-to-board connectors 428 are mounted to board 422. 90-pin connectors 414 are connected through housing 404 to boards 416. Boards 416 include one or more board-to-board connectors 418, which mate with the one or more board-to-board connectors 428 to electronically link card edge connectors 104 of switching modules 100 to audio cables connected to 90-pin connectors 414. In housings 402 and 404 are mounting openings 406 and 410 for mounting module 400 to chassis 10 with fasteners inserted through openings 406 and 410 and into openings 18 in second upper plate flange 32 and second lower plate flange 34. Even though the ends of module 400 are open, access to the fasteners for mounting or removal from a chassis 10 may be difficult, since multiple modules 200, 300 and 400 may be mounted side-by-side, blocking the open ends. Upper access slots 408 and lower access slots 412 allow users to see and engage the fasteners, such as with a screwdriver, even when additional modules are mounted alongside module 400. Openings 406 and 410, and access openings 408 and 412 extend through both housings 402 and 404. Openings 406 and 410 are configured as upwardly facing and downwardly facing slots, respectively. A chassis ground 424 and an isolated ground 426 are provided in module 400 and depending on the wiring requirements of a particular application, card edge contacts 104 linked to the common ground circuit on switching module 100 will be linked to one or the other of these grounds.

Designation device 108 is preferably a lens at least partially transparent to visible light so as to allow viewing of indicia held behind the lens, such as an indicia card. Referring now to FIGS. 31 to 36, details of an alternative embodiment lens 508 of designation device 108 for switching module 100 are shown. Lens 508 includes

5 opposing sides 520 and 522, opposing ends 524 and 526, and front face 512 and rear face 514. Flats 516 are located at the rear of lens 508 and tabs 510 extend from flats 516 adjacent to sides 520 and 522. Lens 508 holds indicia on face 140 adjacent to jack 106. Like lens 108, lens 508 is mounted to face 140 by inserting tabs 510 into

10 mounting slots 109 in face 140 of switching module 100. When mounted to face 140, flats 516 rest against face 140. As shown in FIG. 36, line BB represents face 140. Line BB cooperates with rear face 514 and inner walls 528 to form an open ended indicia area 518, where indicia of the circuits connected to the adjacent jack 106, for example a paper strip, may be placed. Ends 530 of area 518 are open adjacent to opposing ends 524 and 526. These open ends 530 allow indicia to be slid directly into area 518 when

15 no modules are mounted in a chassis 10 adjacent to the module 100 to which lens 508 is attached. If an adjacent module interferes with direct access to open ends 530, open ends 530 also provide an opening to insert a tool, such as a thin flat screwdriver blade into lever lens 508 from face 140. Designation lens 108, shown in FIGS. 3 through 9, has closed ends. To insert indicia into area 518 of a lens 108, a tool such as a thin probe or a wire end is inserted into opening 532 to lever lens 108 from face 140.

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The distance between opposing ends 524 and 526 is approximately equal to the width of face 140, though slightly smaller so as not interfere with adjacent modules when mounted in chassis 10. As shown, this distance is approximately 0.5 inches. Due to the small size of the lenses 508 and thus the limits on the size of the indicia held by the lenses, some element of magnification by the lenses may be desired.

25 This is accomplished by using different radii of curvature for front face 512 and rear face 514. As shown in FIG. 36, when viewed in cross section, rear face 514 is essentially planar while front face 512 is shaped along a radius of curvature to provide magnification of indicia within area 518 when viewed through front face 512. Rear face

514 could also be formed with a radius of curvature about the same origin as the radius of curvature of front face 512. The difference in curvature of front face 512 and rear face 514 should be selected in conjunction with the properties of the transparent material used to make the lens to achieve the desired level of magnification.

5 With regard to the foregoing description, it is to be understood that changes can be made in detail, especially in matters of the construction materials employed and the shape, size and arrangement of the parts without departing from the scope of the present invention. It is intended that the specification and the depicted aspects be considered exemplary only, with a true scope and spirit of the invention
10 being indicated by the broad meaning of the following claims.